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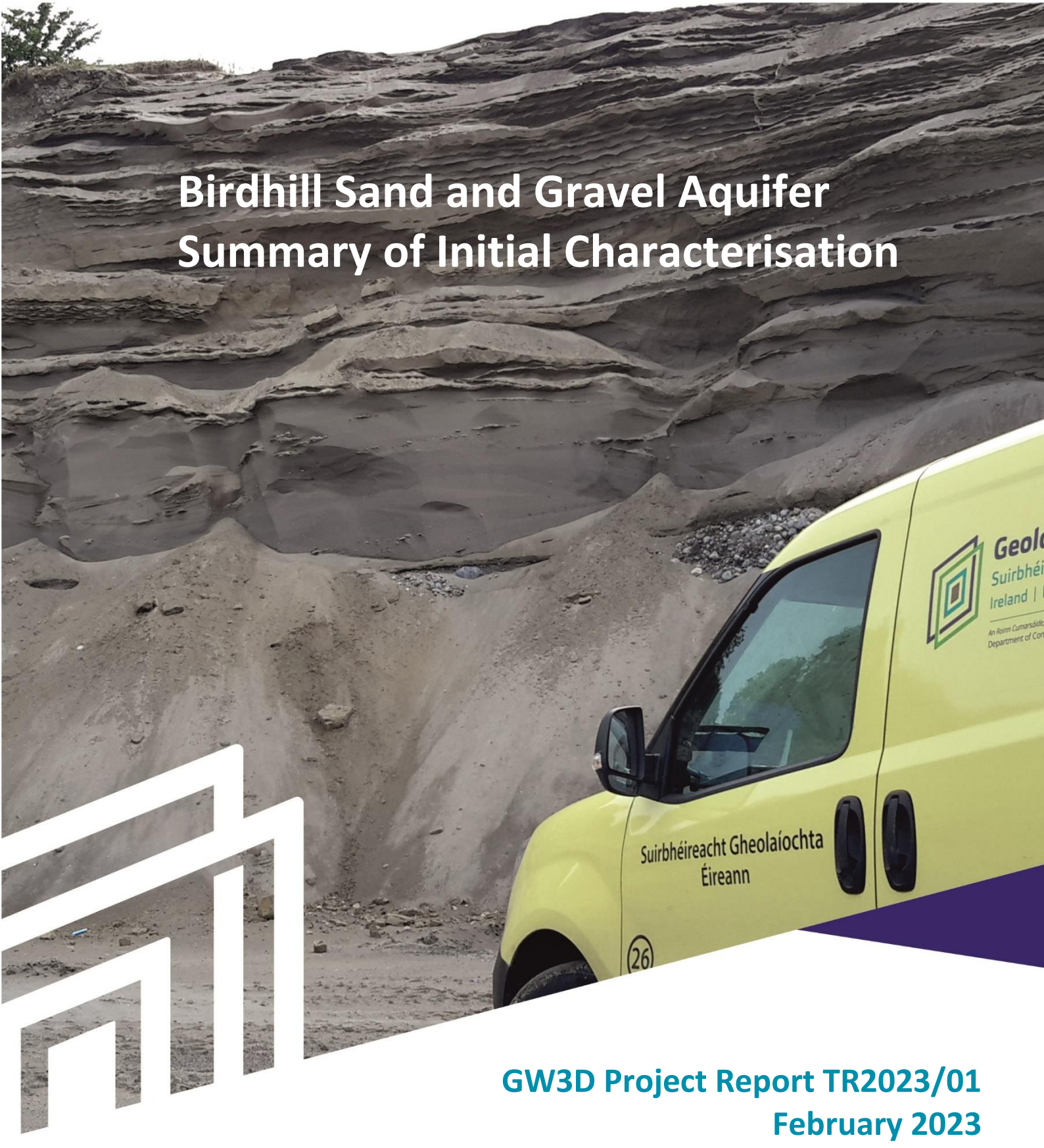

Birdhill Sand and Gravel Aquifer
Summary of Initial Characterisation

GW3D Project Report TR2023/01
February 2023

Geological Survey Ireland is a division of the Department of the Environment, Climate and Communications

Birdhill Sand and Gravel Aquifer Description February 2023

This sand and gravel report forms part of a series representing the output of a body of work undertaken to re-evaluate previously mapped sand and gravel aquifers and to identify new sand and gravel aquifers. This study resulted in the refinement of existing sand and gravel aquifer mapped extents, the modification of some sand and gravel aquifer categories, and the removal of some previously mapped sand and gravel aquifers, as well as identification of new aquifers. In addition to mapping the extent and depths of the sand and gravel aquifers, the investigations consider the hydraulic properties.

The study, undertaken as part of the GW3D project (2015-2019), comprised three parts:

1) Desk study and fieldwork preparation

Sand and gravel bodies above a minimum size criterion were extracted from the GSI Quaternary Sediments 1:50,000 map. Where it was known that the surface expression of the sands and gravels was only a small portion of the subsurface body, such areas were retained. This process left several hundred sand and gravel bodies remaining as a starting point for field work.

2) Fieldwork including mapping and data collection

Field work included a visit to each of the areas which had the potential to be (at least) a Locally Important Sand and Gravel Aquifer owing to its area. In such areas, gravel pits and sand pits were visited and depth and type of sediment recorded, other exposures into the subsurface were visited and logged, wells (whether Public Supply, Group Scheme or private farm or domestic) were dipped and any information on depths recorded, and data was collected where geological and hydrogeological data existed for the area.

3) Data collation, analysis and reporting.

All field data, and information from earlier reports and studies, were compiled and analysed. Where a sand and gravel body had qualifying aquifer properties (either 10 m depth sand and gravel, or 5 m depth saturated sediments), these areas were digitised in a GIS. The aquifer area was then ascertained and drawn up. Such areas formed the basic building blocks for the sand and gravel aquifer map, which included details on the aquifer name, area, aquifer resource value (Rg or Lg), confidence level, county, and any important aspects to note for each body.

The updated mapped sand and gravel aquifers are found on the Geological Survey Ireland site
https://www.gsi.ie/en-ie/data-and-maps/Pages/Groundwater.aspx#Aquifers

The GW3D Mapping Team involved in the current revision of delineated sand and gravel aquifers were:

Geological Survey Ireland staff:

- Dr. Sophie O'Connor, Groundwater Programme / Land Mapping Unit
- Dr. Sarah Blake, Groundwater Programme

Consultant support:

- Dr. Robbie Meehan, Talamh Ireland
- Coran Kelly, Tobin Consulting Engineers
- Damien Doherty, independent Consultant Geologist/ Tobin Consulting Engineers
- Natalie Duncan, independent Consultant Geologist
- Sara Raymond, independent Consultant Geologist
- James McAteer, Gavin and Doherty Geosolutions

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Birdhill Sand and Gravel Aquifer: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
25 - Lower Shannon Tipperary County Council	**Rivers:** Killmastulla River **Streams:** Several unnamed streams **Lakes:** One unnamed Motorway Pond	Lower River Shannon SAC	1.3

Topography	This sand and gravel deposit is situated northeast of Birdhill, along the southern flank of the Killmastulla River, covering an area of 1.3 km^2. In the east the sand and gravel is hummocky but the topography flattens westwards towards the extensive alluvial flat of the Kilmastulla and Shannon River confluence. The topographic elevations in the area of the aquifer body range from 25 m to 45 m AOD. The aquifer is bounded by a steep ridge of shallow till deposits and bedrock close to surface at the south and southeast, and is itself a portion of the Shannon glaciofluvial terraces.	
Geology and Aquifers	**Aquifer categories**	The sand and gravel deposit at Birdhill has previously been characterised as a part of the previously-delineated Silvermines Locally Important Sand and Gravel Aquifer. Further investigation indicates that the sands and gravels do not extend beneath the majority of the alluvium in the locality, as had been previously thought (GSI, 2023a). The Birdhill sand and gravel deposit is confirmed to be greater than 10 m in thickness and have a saturated thickness greater than 5 m. The thickness, saturated thickness and areal extent satisfy the criteria of a **Locally Important Sand and Gravel Aquifer (Lg)** (DELG/EPA/GSI, 1999; GSI, 2017).
	Main aquifer lithologies	The main component of the aquifer is glaciofluvial sands and gravels derived chiefly from Lower Palaeozoic and Devonian sandstones (GLPDSs), as well as overlying alluvium (A) (GSI, 2023b).
	Key structures	Borehole logs (GSI, 2023c) from within the area of the aquifer body show the variability of the subsurface material which consists largely of sands and gravels with occasional low permeability horizons. The underlying rock units are Dinantian Lower Impure Limestones and Dinantian (early) Sandstones, Shales and Limestones (GSI, 2023b) which are Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones **(Ll)** and Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones **(Pl)** respectively (GSI, 2006). The sand and gravel deposit is in direct contact with bedrock, and being relatively poor aquifers, the bedrock aquifers beneath the sand and gravel have a high degree of rejected recharge associated with them. Thus, significant volumes of groundwater is expected to be retained within the sand and gravel aquifer.
	Key properties	The groundwater in the Birdhill Sand and Gravel Aquifer body is considered to be generally unconfined; however, where clay layers are present within and above the sand and gravel deposit, the aquifer may be locally confined. This is expected to be increasingly the case moving westwards through the area of the aquifer body, onto the lower ground. Though permeability testing data are limited, borehole logging data indicate that coarse material predominates and that permeability and storativity are therefore high. In the absence of permeability test data, gravels with a fines content of less than approximately 8% are generally considered to have sufficient permeability for aquifer development (O'Suilleabhain, 2000).
	Thickness	Recorded thicknesses of the sand and gravel material in the deposit range between 12 m to 29 m (GSI, 2023c).
Overlying Strata	**Lithologies**	Till and alluvial sediments are mapped as overlying portions of the sand and gravel body (GSI, 2023b).
	Thickness	The thickness of the alluvial and till deposits is unknown, and the alluvium may be of significant depth moving northwards towards the River Shannon.
	% area aquifer near surface	Approximately 50 % of the area of the sand and gravel body has sands and gravels just below the surface.

	Vulnerability	Sand and gravel aquifers are categorised as having either 'High or 'Extreme' vulnerability (DELG/EPA/GSI, 1999) with the vulnerability classification determined by the depth to the water table from ground level. In areas where the water table is less than three metres below ground level the aquifer vulnerability is 'Extreme' and where it is greater than three metres below ground level the aquifer vulnerability is 'High'. About 55% of the aquifer is categorised as being 'Extremely' vulnerable on this basis.
Recharge	**Main recharge mechanisms**	Diffuse recharge occurs *via* infiltration of rainfall through the unsaturated sands and gravels. The proportion of the effective rainfall that recharges the aquifer is largely determined by the thickness and permeability of the soil and subsoil, and by the slope (DoELG/EPA/GSI, 1999). Typically the proportion of recharge that infiltrates to groundwater in sand and gravel is around 85% (Hunter Williams et al., 2011). The presence of less permeable layers in the deposit, even if thin, can create perched water tables and prevent recharge of the true water table. Where the water table lies below the local river network it is likely that some stream water may pass into the aquifer. In the setting at Birdhill, rejected recharge from the surrounding hills will increase the amount of available recharge to the aquifer.
	Est. recharge rates	The rainfall in the area of the Birdhill sand and gravel deposit is 1,140 mm/yr (Walsh, 2012), and the estimated recharge rate to the aquifer from direct recharge is 350 mm/yr. The minimum direct groundwater throughput in the aquifer is consequently estimated to be only 678 m^3/d, but with rejected recharge the throughput increases to an approximate potential 1,578 m^3/d.
Discharge	**Large springs and large known abstractions (m^3/d)**	There are no known large springs or abstractions from this aquifer body.
	Main discharge mechanisms	The main discharge mechanisms are baseflow discharge to rivers and seepages at the extremities of the body. Where the water table is sufficiently close to the surface such that the riverbed elevation is lower than it is, the aquifer will contribute groundwater to the baseflow of the Killmastulla River.
	Hydrochemical Signature	There are no data readily available to assess the hydrochemistry of this aquifer
Groundwater Flow Paths		The length of flow paths depend on the size of the sand and gravel deposit. In general, locally Important sand and gravel aquifers are expected to have relatively short flow paths *i.e.* up to several hundreds of metres. This is likely to be the case at Birdhill, given the geometry, topography and surface hydrology of the aquifer body.
Groundwater & Surface water interactions		Hydraulic connection between the groundwater in the aquifer and streams and rivers passing through it is expected to be high.
Conceptual model		• The sand and gravel aquifer is comprised of glaciofluvial sand and gravels derived from Lower Palaeozoic and Devonian sandstones (GLPDSs), as well as some overlying and flanking alluvium (A). • The boundaries of the aquifer body are delimited for the most part by the extent of the mapped sand and gravel materials (GSI, 2023b). However, where borehole logging indicates sand and gravel below the mapped alluvial subsoils, these areas are also included within the area of the aquifer. • The underlying bedrock aquifers are Dinantian Lower Impure Limestones and Dinantian (early) Sandstones, Shales and Limestones (GSI, 2023b) which are a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones **(Ll)** and Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones **(Pl)** respectively (GSI, 2006). • Diffuse recharge occurs *via* rainfall percolating through the unsaturated sand and gravel.

	• Rejected recharge from the areas of higher elevation flanking the aquifer body, and underlain by relatively poor aquifers, also contribute to the groundwater resource in the sand and gravel aquifer at Birdhill. • The length of groundwater flow paths is expected to be in the order of several hundred metres. • The groundwater gradient is interpreted to be relatively shallow, and sloping to the west. • The groundwater discharges to the Killmastulla river and at seepages along the extremities of the body. • The minimum direct groundwater throughput in the aquifer is consequently estimated to be only 678 m^3/d, but with rejected recharge the throughput increases to an approximate potential 1,578 m^3/d.
Attachments	Figure 1: Location and extent Figure 2: Cross sections Figure 3: Groundwater vulnerability
Instrumentation	**Hydrometric gauges:** 25044 KILMASTULLA (Recorder) **National Water Monitoring Stations;** **River:** RS25K041000 Cool Bridge RS25K041100 KILMASTULLA - Cooly's Br **Groundwater:** None present
Information Sources	• DELG/EPA/GSI (1999). Groundwater Protection Schemes. Department of the Environment and Local Government, Environmental Protection Agency and Geological Survey of Ireland. • EPA (2023). Environmental Protection Agency Map Viewer. https://gis.epa.ie/EPAMaps • GSI (2017). A description of Irish aquifer categories. 3 pp. Available from: https://www.gsi.ie/documents/GSI%20Aquifer%20Category%20Descriptions.pdf • GSI (2023a). Geological Survey Ireland internal groundwater database. • GSI (2023b). Geological Survey Ireland Map Viewer. https://www.gsi.ie/en-ie/data-and-maps • GSI (2023c). Geological Survey Ireland. Internal Bedrock Database • Hunter-Williams, N.H., Misstear, B.D.R., Daly, D. and Lee, M. (2011). Development of a national groundwater recharge map for the Republic of Ireland. Quarterly Journal of Engineering Geology and Hydrogeology, 46(4):493-506. • NPWS (2023). National Parks and Wildlife Service Map Viewer. http://webgis.npws.ie/npwsviewer • Ó'Suilleabháin, C. (2000). Assessing the boundary between high and moderately permeable subsoils. Unpublished MSc., University of Dublin. Department of Civil, Structural and Environmental Engineering, Trinity College Dublin. • Walsh, S. (2012). A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14, Met Éireann, Dublin.
Disclaimer	Note that all calculations and interpretations presented in this report represent estimations and assumptions based on the information sources described above and established hydrogeological formulae. Figures 1, 2 and 3 are used for illustrative purposes only.

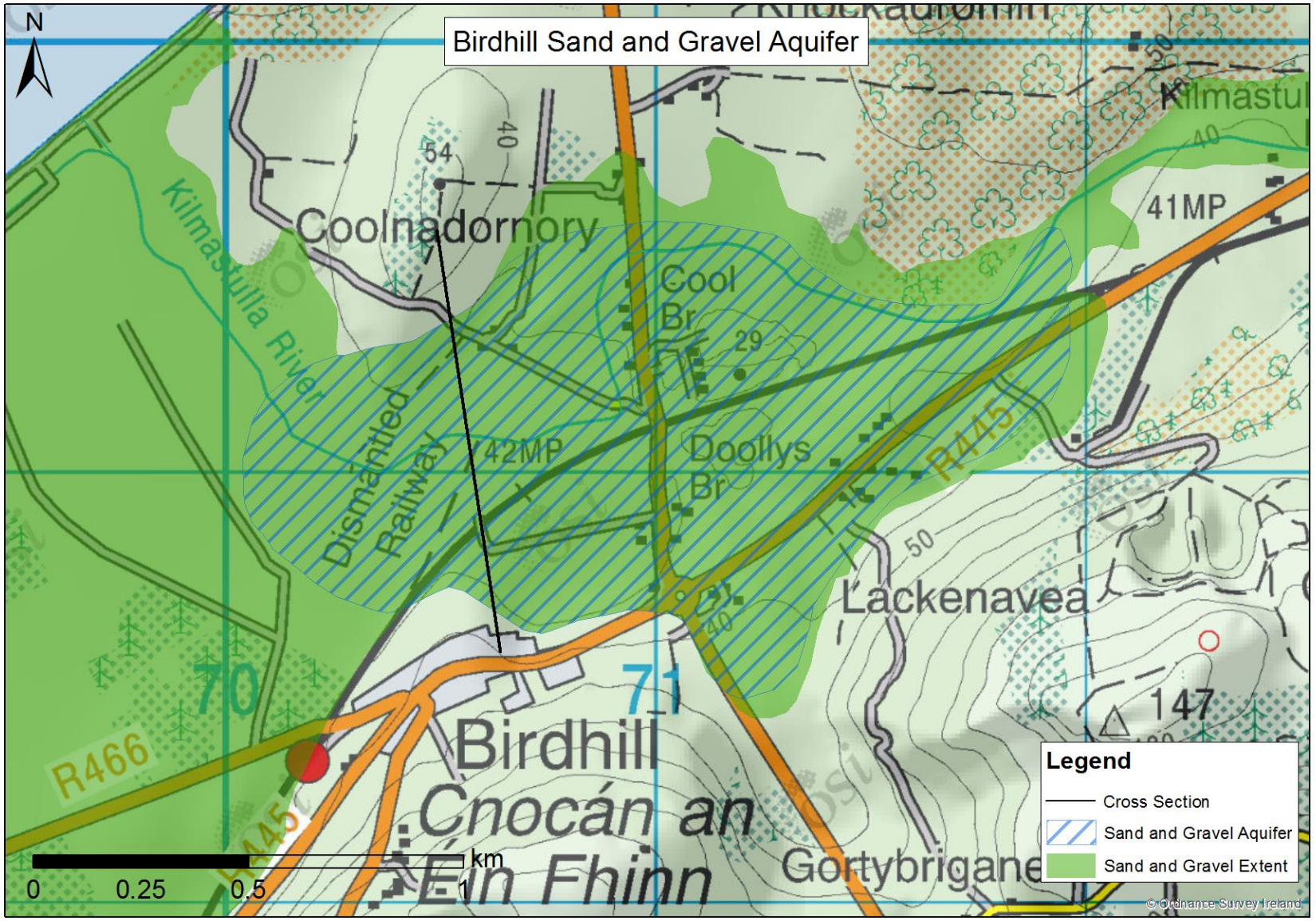
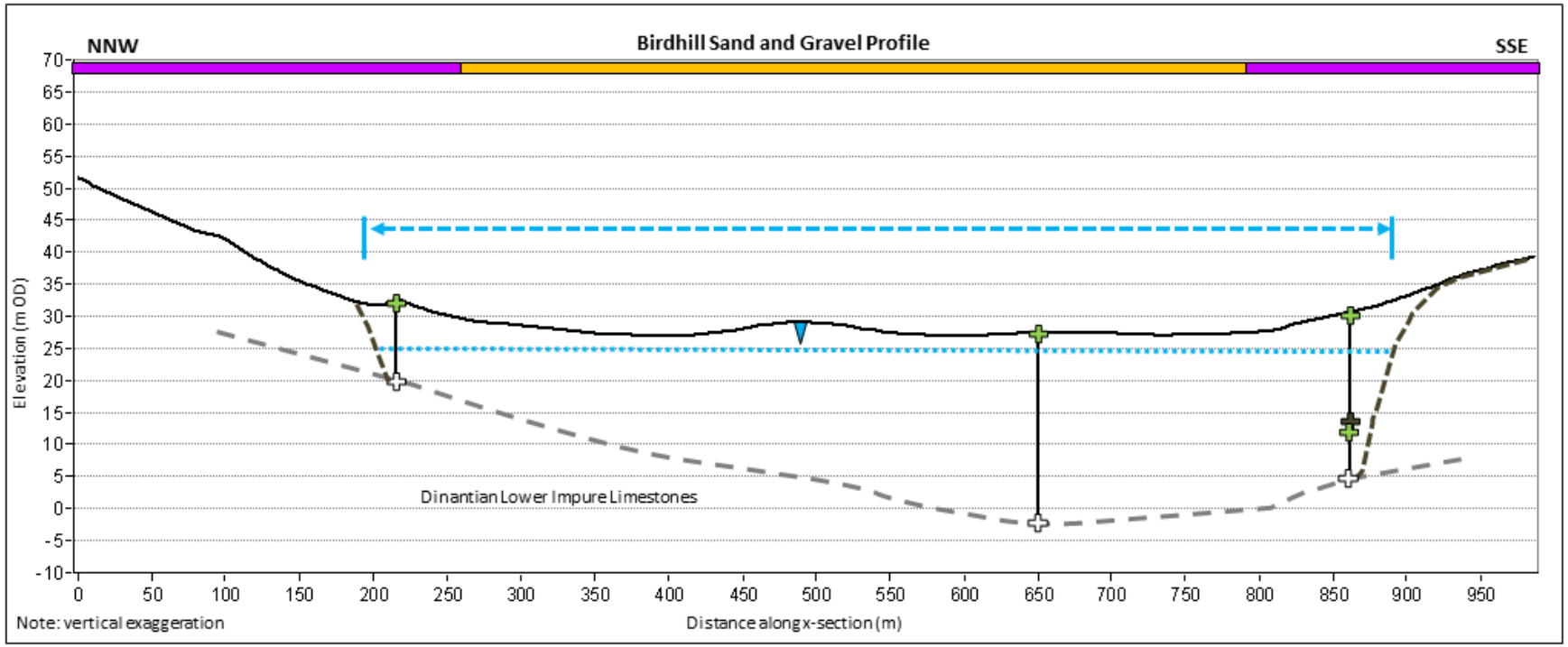


Figure 1: Birdhill Sand and Gravel Aquifer extent with cross section location.



Elevation		River	
Groundwater level		Presumed Groundwater level	
Top of S&G		Presumed Top of till	
Top of till		Top of bedrock	
Top of bedrock		Till	
Borehole/Trial Pit		Alluvium	
Aquifer Extent			

Figure 2: Cross section through the Birdhill Sand and Gravel Aquifer body.

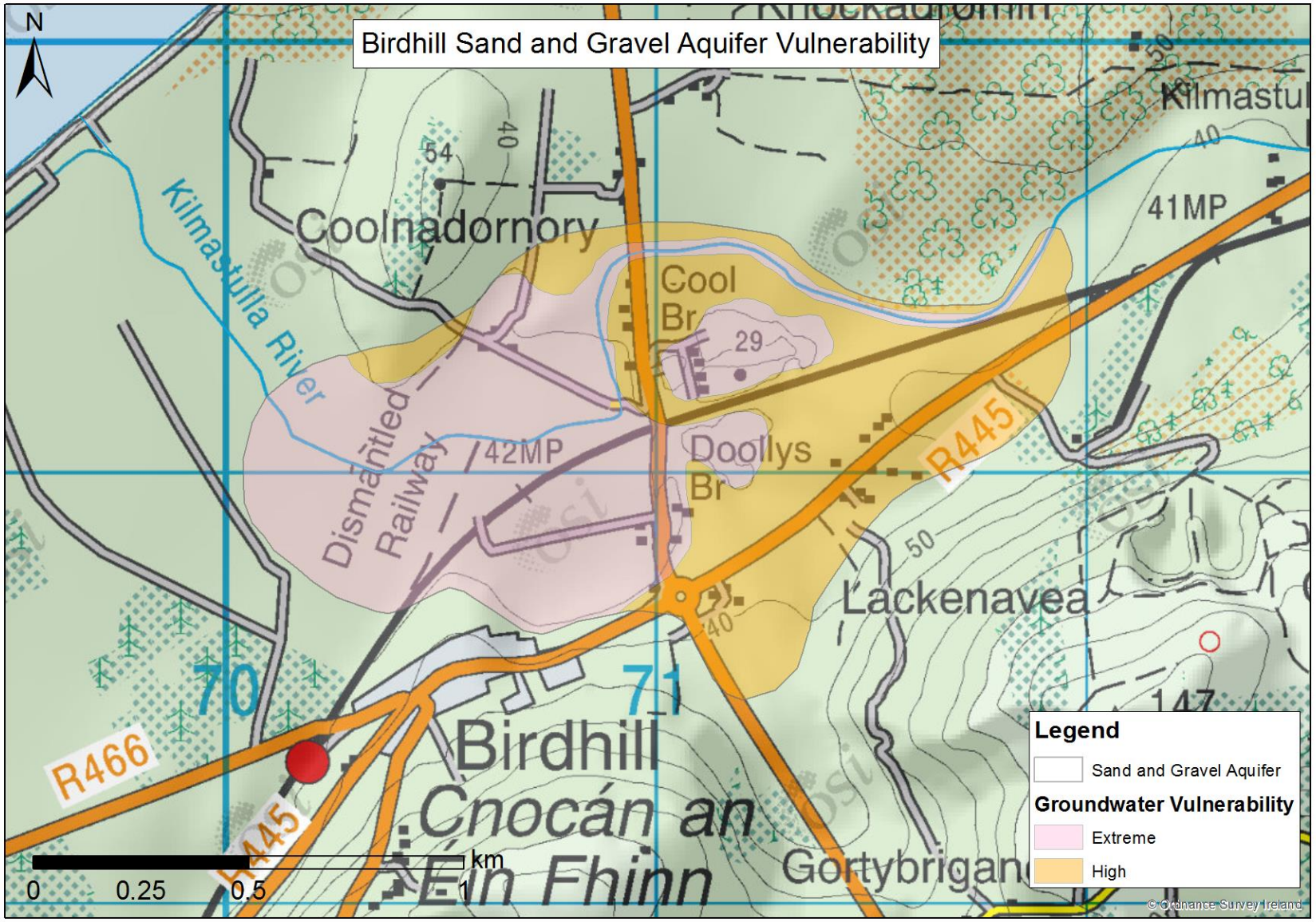


Figure 3: Groundwater vulnerability across the Birdhill Sand and Gravel Aquifer.